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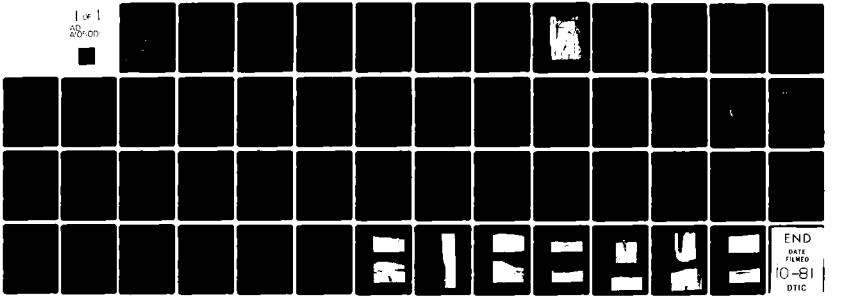

LEVEL II

MISSISSIPPI - KASKASKIA - ST. LOUIS BASIN

SHEPARD MOUNTAIN DAM

IRON COUNTY, MISSOURI

MO 30324

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY INSPECTION

United States Army
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St. Louis District

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PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

AUGUST 1979

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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7. AUTHOR(s) L. Robert Kimball and Associates (10) L. Robert Kimball	8. CONTRACT OR GRANT NUMBER(s) (15) DACW43-79-C-0034
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.	

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SHEPARD MOUNTAIN DAM

IRON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30324

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY

L. ROBERT KIMBALL AND ASSOCIATES
CONSULTING ENGINEERS AND ARCHITECTS
EBENSBURG, PENNSYLVANIA

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

AUGUST 1979

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Shepard Mountain Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Shepard Mountain Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division

23 AUG 1979
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

23 AUG 1979
Date

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through frequent inspections can unsafe conditions be detected and only through continued care and maintenance can these conditions be prevented or corrected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the spillway design flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The spillway design flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

NAME OF DAM	Shepard Mountain Dam
STATE LOCATED	Missouri
COUNTY LOCATED	Iron
STREAM	Unnamed Tributary to Stouts Creek
DATE OF INSPECTION	30 April 1979

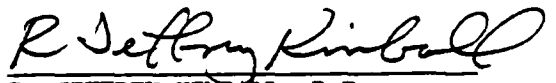
Shepard Mountain Dam was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U.S. Army, Washington, D.C., with the help of federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The dam is in the small size classification since it is greater than 25 feet high but less than 40 feet high. The downstream affected area includes Highway M located immediately downstream of the dam, a dwelling .15 miles downstream, a dwelling .35 miles downstream, and portions of the towns of Ironton and Acadia 2.5 miles downstream of the dam. Based on this downstream exposure the Spillway Design Flood for this dam is the PMF.

Because of the configuration of the dam with a total overflow spillway section, the dam is capable of controlling the PMF from a hydrologic standpoint. However, spillway capacity is related to the structural adequacy of the dam. If the dam cannot withstand the high loading induced by the PMF then it can be stated that the spillway cannot control the PMF. No structural analyses have been performed on the structure and it is uncertain whether the dam can tolerate the loading.

Deficiencies visually observed for Shepard Mountain Dam were minor spalling of the gunite surface and inoperable valves. It must be noted that the condition of the concrete under the gunite and on the upstream face was unobserved. These deficiencies should be remedied at the direction of a professional engineer knowledgeable in dam design to avoid creating an unsafe condition. Concrete may deteriorate with age and review of the safety of the structure should be made at an on-going basis. The lack of stability, stress and seepage analyses, a warning system, and a formal inspection program should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described.



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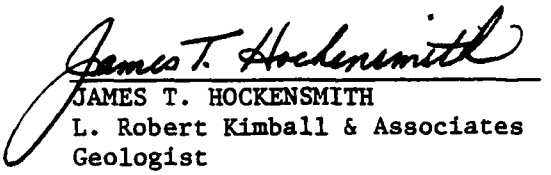

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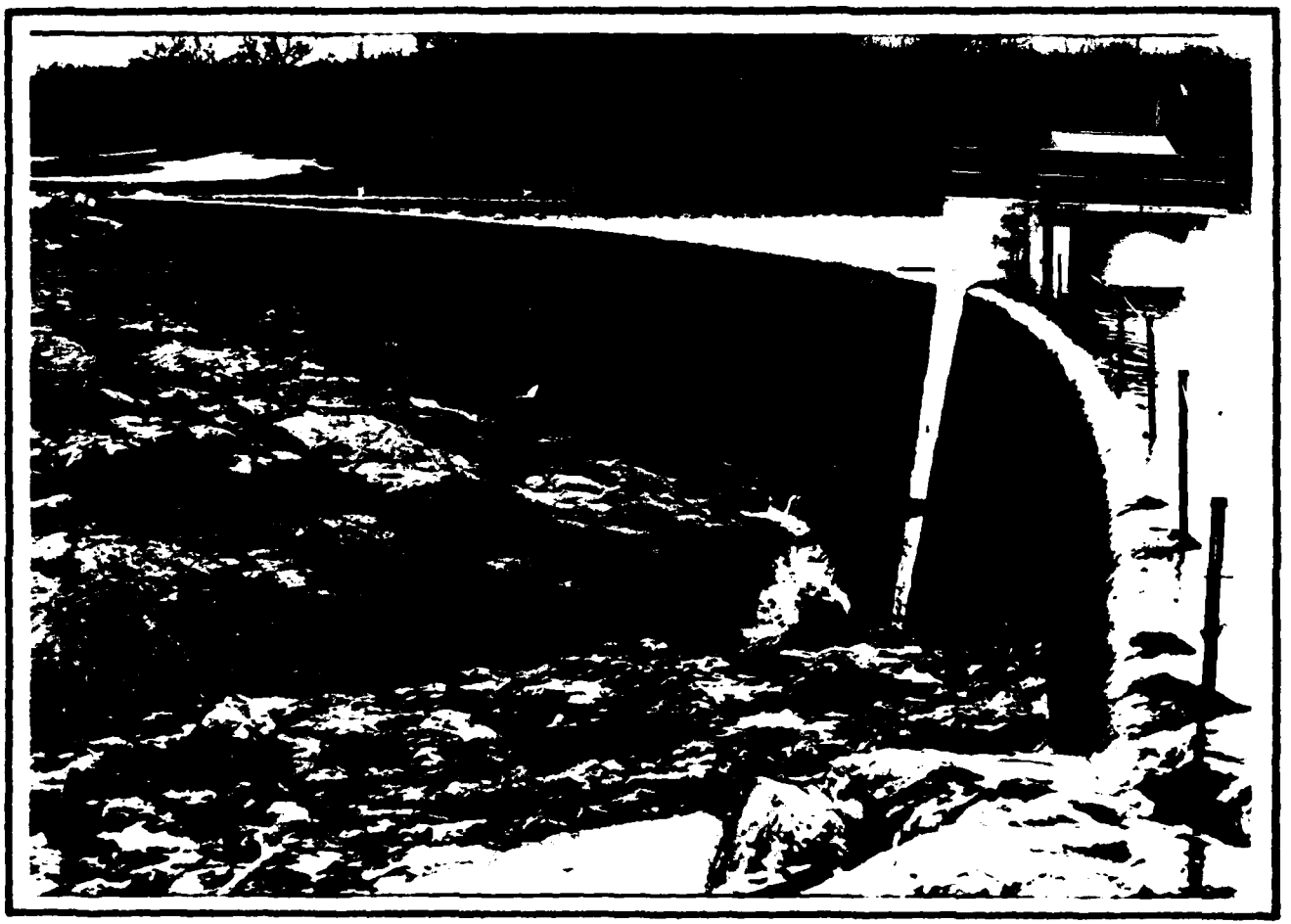

Shepard Mountain Dam - Overview

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NATIONAL DAM SAFETY PROGRAM
SHEPARD MOUNTAIN LAKE DAM - ID NO. 30324

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL.

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Shepard Mountain Lake Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based on available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several Federal Agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) Shepard Mountain Lake Dam is a concrete arch dam with a concrete section at the right abutment. The arch portion of the dam is 287.4 feet long and approximately 35 feet high. The dam has a felsite foundation. The top width of the dam is 4 feet, the base thickness is unknown. The right abutment is formed by a 90 foot long concrete section. This concrete section is approximately 5 feet high. The top width is 2 feet. The left abutment is formed by a felsite outcrop. Beyond this felsite outcrop is a concrete wingwall approximately 2 feet high.

The outlet works consist of two 8 foot diameter concrete towers. In the concrete towers are pumps which pump water to the water treatment plant. Three drainlines are located through the concrete arch section of the dam. These drainlines are 6", 9" and 12" cast iron pipes. Both the concrete arch and concrete abutment section act as overflow sections and form the spillway.

Upstream of Shepard Mountain Lake is Snow Hollow Dam (drainage area 481 acres). Snow Hollow Dam is an earth fill dam 530 feet long and 35 feet high. The dam has two spillways cut in rock (one on each abutment).

Immediately downstream of Shepard Mountain Dam is State Road M. Overflow from the spillway flows under State Road M through a box culvert.

b. Location. Shepard Mountain Lake Dam is located approximately 1.5 miles west of Ironton, Missouri on an unnamed tributary to Stouts Creek. The dam can be located (Section 1, Township 33 North, Range 3 East) on the Ironton, Missouri 7.5 minute U.S.G.S. Quadrangle.

c. Size Classification. Shepard Mountain Lake Dam is a small size dam (36 feet high, 168 acre-feet).

d. Hazard Classification. Shepard Mountain Lake Dam is a high hazard dam. Downstream conditions indicate that loss of life is probable should failure of the structure occur.

e. Ownership. Shepard Mountain Lake Dam is owned by the City of Ironton. Correspondence should be addressed to:

City of Ironton
Ironton, Missouri 63650
314-546-3069

f. Purpose of Dam. Shepard Mountain Lake Dam is used for water supply.

g. Design and Construction History. Design and construction history was unavailable for Shepard Mountain Lake Dam. No design drawings, reports or construction history exists.

h. Normal Operating Procedures. No operating records exist. The reservoir is maintained at the spillway crest with the excess inflow discharging over the spillway. Water is drawn off the reservoir on an as-needed basis.

1.3 PERTINENT DATA

a.	Drainage Area.	7.07 square miles (includes upstream dam)
b.	Discharge at Damsite (cfs).	
	(1) Maximum known flood at dam site	Approximately 10,000 in 1974
	(2) Ungated spillway capacity	PMF - 52,054
	(3) Gated spillway capacity	N/A
	(4) Drainlines	Unknown

c. Elevation (feet) - Based on spillway crest shown on U.S.G.S. quadrangle.

(1)	Top of dam	977.0
(2)	Spillway crest	977.0
(3)	Normal pool	977.0
(4)	Maximum pool (PMF)	987.0
(5)	Invert 6" CIP	953.5
(6)	Invert 9" CIP	963.5
(7)	Invert 12" CIP	949.5
(8)	Tailwater on day of inspection	944.5
(9)	Streambed at centerline of dam	941.0

d. Reservoir (feet).

(1)	Length of maximum pool	2300
(2)	Length of normal pool	2300

e. Storage (acre-feet).

(1)	Top of dam	168
(2)	Spillway crest	168
(3)	Normal pool	168
(4)	Maximum pool (PMF)	558

f. Reservoir Surface (acres).

(1)	Top of dam	21
(2)	Spillway crest	21
(3)	Normal pool	21
(4)	Maximum pool (PMF)	56

g. Dam.

(1)	Type	Concrete arch
(2)	Length	377.5 feet
(3)	Height	36 feet
(4)	Top width	4 feet - concrete arch section 2 feet - concrete abutment section
(5)	Side slopes	Upstream - unknown Downstream - near vertical
(6)	Zoning	None
(7)	Grout Curtain	None
(8)	Cutoff	Unknown

h. Diversion and Regulating Tunnel.

(1)	Type	6", 9", and 12" Cast Iron Pipes
(2)	Elevation (feet)	6" - 953.5 9" - 963.5 12" - 949.5

(3)	Length	Each approximately 8 feet long
(4)	Closure	Downstream of dam
(5)	Access	Downstream of dam

i. Spillway.

(1)	Type	Uncontrolled-broad crested weir
(2)	Length	377.5 feet
(3)	Crest elevation	977.0 feet
(4)	Upstream channel	Lake
(5)	Downstream channel	Unnamed tributary to Stouts Creek and Stouts Creek
(6)	Gates	None

SECTION 2 - ENGINEERING DATA

2.1 DESIGN. No design drawings, reports or data are known to exist.

2.2 CONSTRUCTION. The date of original construction is unknown. The lake was reportedly used for recreation. In 1955, the City of Ironton bought the reservoir. At this time, the dam was raised 5 feet and gunited.

2.3 OPERATION. No operating records exist.

2.4 EVALUATION

a. Availability. No engineering data is available.

b. Adequacy. The field surveys and visual inspections presented herein are considered adequate to support the conclusion of this report. Seepage and structural analyses comparable to the requirements of the guidelines are not on record. This is a deficiency which should be rectified.

c. Validity. Not applicable.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General. The onsite inspection of Shepard Mountain Lake Dam was conducted by personnel of L. Robert Kimball and Associates accompanied by the owner's water superintendent, Ralph Kloess, on April 30, 1979. The inspection team consisted of a hydrologist, structural/soils engineer and a geologist. The inspection consisted of:

1. Visual inspection of the retaining structure, abutments and toe.
2. Examination of the spillway facilities, exposed portions of any outlet works, and other appurtenant works.
3. Observations affecting the runoff potential of the drainage basin.

b. Project Geology. Shepard Mountain Lake Dam is underlain by Precambrian felsites. These are chiefly rhyolite porphyries with some rhyolites and tuffs.

Structural features in the area include the Ironton and Hogan Mountain Faults. The Ironton Fault has not yet been fully substantiated but is believed to extend for over ten miles in a northwest-southeast direction and to pass within two miles northeast of the dam. It is also uncertain as to whether this is a normal or reverse fault and what the displacement is since little work has been done in this area.

The Hogan Mountain Faults lie approximately 1 to 2 miles southwest of the dam. They consist of three faults which strike to the northeast. The down thrown sides are the northwestern sides, but the displacements are unknown. Jointing is probably present in these rocks, but to an unknown degree.

c. Dam and Spillway. Visual inspection of the dam indicated the structure was in good condition. From a brief survey conducted during the inspection it was determined that the spillway elevation is fairly even (977.0). The entire dam is covered with gunite. Close examination of the concrete was impossible because of the gunite surface. One portion of the gunite was missing (see Figure 2 for location). Because of the water discharging over the spillway and running down the face of the dam, examination for any seepage zones was not possible. No cracks or major deteriorated zones were noted. Approximately 3 feet of tailwater was present during the inspection. The right and left abutments are formed by gently sloping grassed areas with occasional felsite outcrops.

d. Appurtenant Structures. The outlet works consist of two 8 foot diameter concrete towers. It is reported that pumps are located in the concrete towers to pump water to the water treatment plant. Examination of the inside of the outlet works was not conducted during the inspection. Three drainlines are located through the dam at different elevations. The drainlines are 6", 9" and 12" cast iron pipes. The 6" and 9" cast iron pipes contain no valves at the discharge end. The 12" cast iron pipe is inoperable because of a cracked valve. It was reported by the water superintendent that the drainlines have not been operated since 1955.

e. Reservoir Area. No pertinent problems were noted in the reservoir area. The watershed is moderately steep, wooded and undeveloped.

f. Downstream Channel. Discharges from the spillway enter the unnamed tributary of Stouts Creek for a distance of approximately 400 feet before flowing into Stouts Creek.

3.2 EVALUATION. The visual inspection did not reveal any immediate signs of instability. The dam appeared to be in good condition. However, the presence of the gunite over the entire concrete surface may obscure deterioration of the concrete. In addition, water flowing over the spillway weir and down the downstream portion of the dam may have obscured any seepage present. Examination of the upstream face was impossible because of the high reservoir level.

Complete evaluation of the structure cannot be made without a detailed stability analysis or stress analysis with test results of the concrete and knowledge on the geometry of the section.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES. The reservoir is maintained at the spillway crest at all times. Water is drawn off the reservoir on an as-needed basis.

4.2 MAINTENANCE OF THE DAM. No major maintenance of the dam has been conducted since the dam was purchased by the City of Ironton in 1955.

4.3 MAINTENANCE OF OPERATING FACILITIES. The outlet works are maintained on an as-needed basis. The drainlines have not been maintained since before 1955.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT. There is no warning system in effect.

4.5 EVALUATION. Maintenance of the dam and operating facilities is considered fair. There is no warning system in effect to warn downstream residences of large spillway discharges or failure of the dam.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. There are no hydraulic and hydrological design data available.

b. Experience Data. The drainage area was developed using the U.S.G.S. quadrangle sheet. The lake surface area was determined by planimetering the quadrangle sheet. Surface area - elevations were determined by planimetering various contour lines within the drainage area on the U.S.G.S. quadrangle sheets. The spillway and dam layout was obtained from surveys conducted during the inspection.

c. Visual Observations. The dam is constructed as a total overflow section. The spillway is 377.5 feet long. During flooding, the right abutment and left abutment will carry flow and act as a portion of the spillway.

d. Overtopping Potential. Overtopping potential was investigated through the development of the probable maximum flood (PMF) for the watershed and the subsequent routing of the PMF and fractions of the PMF through the reservoir and spillway.

The Corps of Engineers, St. Louis District, has directed that the HEC-1 Dam Safety Version systemized computer program be utilized. The program was prepared by the Hydraulic Engineering Center (HEC) U.S. Army Corp of Engineers, Davis California, July, 1978. The major methodologics or key input data for this program are discussed in Appendix B.

To enable us to complete the hydraulic and hydrologic analysis for this structure, it was necessary to make the following assumptions:

1. Water level prior to flood was at the spillway crest or top of dam (elevation 977.0).

2. Flow was allowed over the abutments.

Complete summary sheets of the computer output are presented in Appendix B. To facilitate review, the major results of the overtopping analysis are presented below:

Peak Inflow	53,219 cfs
Maximum Outflow	52,504 cfs

Ratio of PMF	Maximum Reservoir Water Surface El. (ft.)	Maximum Depth over dam (concrete spillway,ft)	Maximum Outflow, (cfs)	Duration of Over-topping, (hours)
.10	979.38	2.38	4649	.67
.20	980.71	3.71	9489	1.92
.30	981.76	4.76	14514	4.75
.40	982.65	5.65	19632	5.75
.50	983.49	6.49	25048	6.08
1.00	986.95	9.95	52054	6.92

The Corps of Engineers Spillway Design Flood for a high hazard-small dam is 1/2 PMF to the PMF. Based on the downstream exposure, the Spillway Design Flood for this dam is the PMF. The spillway is capable of discharging the PMF with flow over the abutments. The abutment sections should be able to withstand some overtopping. Because of the rather shallow soil depth and the nature (felsite) of the bedrock on the abutments, no severe erosion of the abutments is anticipated. The dam is capable of passing the PMF from a hydraulics standpoint, but the dam may not be able to withstand this high overtopping from a structural point. With a high water level the dam could fail from sliding, overstress of concrete, or shearing.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visual observations did not reveal any signs of immediate instability. No zones of cracking or deterioration of the concrete were noted because the gunited surface obscured most of the concrete. No misalignment or deflection of the structure was noted. The foundation rock appears to be competent but the characteristics of the foundation/concrete contact is unknown.

b. Design and Construction Data. No design or construction data is available on the dam. No dimensions of the dam cross-section are known. No testing of the concrete was performed No structural analyses of the dam have been conducted. Stability stress or seepage analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Operating Records. No operating records are kept on the structure.

d. Post-Construction Changes. The dam was raised 5 feet in 1955. No details or drawings are available for this change or the original construction.

e. Seismic Stability. The dam is located in seismic zone 2, to which the guidelines assign a "moderate" damage potential. No seismic structural analysis has been conducted.

SECTION 7 - ASSESSMENT AND RECOMMENDATIONS/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety. The visual observations, review of available data, hydrologic calculations, and past operational performance indicate that Shepard Mountain Lake Dam's spillway is adequate. The spillway is capable of controlling the PMF. This is based on the abutments acting as a portion of the spillway. Since much of the abutments consist of felsite outcrops, it is believed that the abutments can control this flow without any adverse effects. The structural adequacy of the dam is unknown. The structure should be evaluated for critical loading conditions.

The dam appeared to be in good condition. No cracks, seepage zones or deteriorated zones were noted. However, the gunited surface may obscure any deficiencies,if present. No design drawings with data on construction of the dam is available. Stability, stress or seepage analyses comparabe to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

It must be noted that concrete deteriorates with age. Safety reviews of this structure should be made on an on-going basis. Periodic inspections and reevaluation should be conducted.

b. Adequacy of Information. Complete assessment of the structural adequacy of the structure cannot be made because of the limited design data, construction data, and no past stability or stress analyses comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams".

c. Urgency. The deficiencies described herein are serious and corrective actions listed below should be initiated promptly.

d. Necessity for Phase II. In order to accomplish some of the recommendations/remedial measures outlined below, further investigations will be required.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

a. A detailed stability, stress and seepage analysis comparable to the requirements of "Recommended Guidelines for Safety Inspection of Dams" should be conducted by a registered professional engineer knowledgeable in dam design. The analyses should be conducted using the maximum anticipated water levels. Core samples of the concrete should be removed from the dam and the concrete should be tested. The structural adequacy of the Snow Hollow Dam should be periodically checked since failure of this dam would increase overtopping and possible performance of Shepard Mountain Dam.

b. The damaged valve on the 12" cast iron pipe should be repaired.

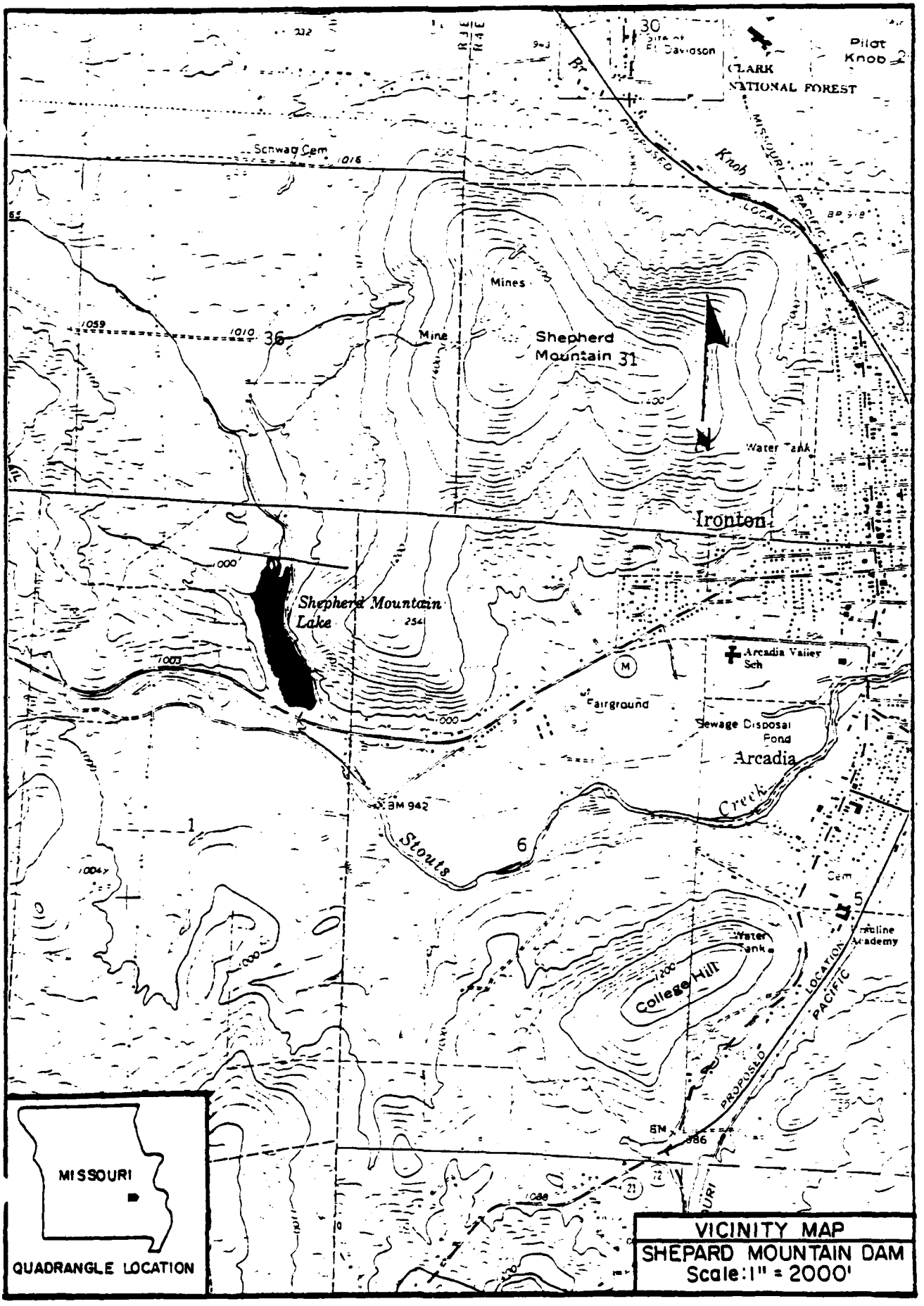
c. All drainlines should be repaired. The valves should be exercised and lubricated at six month intervals.

d. Institute a formal inspection program to be conducted at regular intervals.

e. Institute a formal warning system to warn downstream residences of high spillway discharges or failure of the dam.

APPENDIX A

DRAWINGS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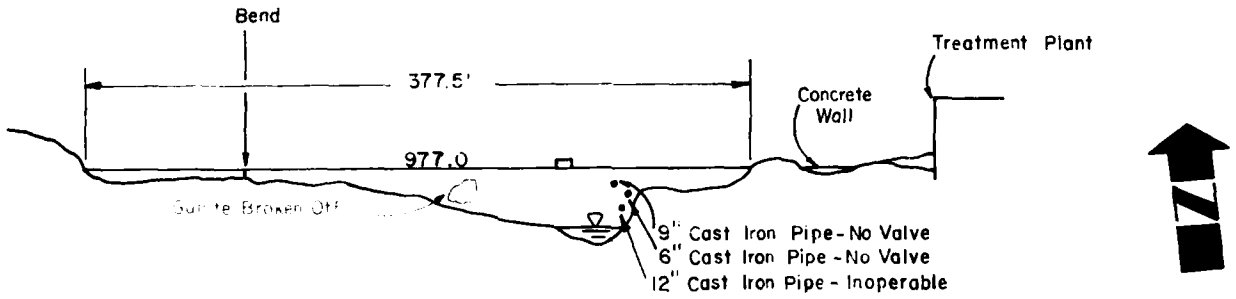
Ironton
Shepherd Mountain Lake
Arcadia Valley Sch
Fairground
Sewage Disposal Pond
Arcadia
BM 942
Stouts Creek
6
1
5
Cem
Water Tank
College Hill
Academy
PACIFIC
LOCATION
PROPOSED
BM 886
MISSOURI
QUADRANGLE LOCATION
VICINITY MAP
SHEPARD MOUNTAIN DAM
Scale: 1" = 2000'



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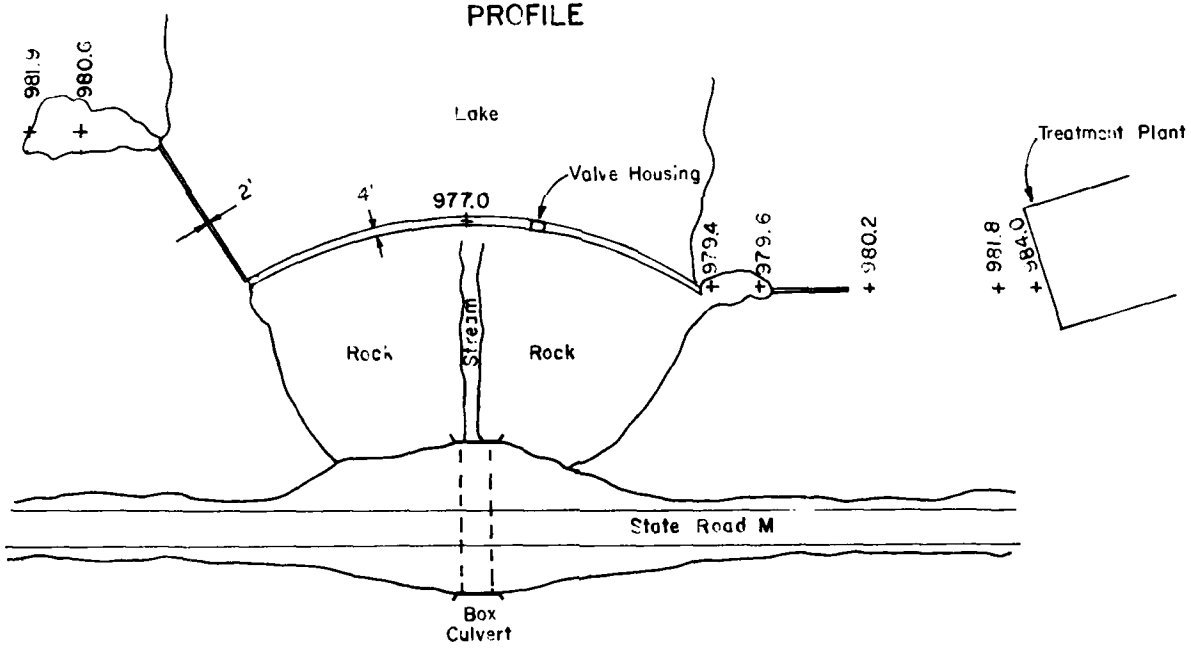


PLAN

SHEPARD MOUNTAIN DAM
Scale: 1" = 100'

FIGURE 2

APPENDIX B

HYDROLOGY AND HYDRAULICS

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 24 hour storm duration is assumed with total depth distributed over 6 hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6 hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The non-peak 6 hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by deduction of infiltration losses appropriate to the soil, land use, and antecedent moisture conditions.

Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

The above analysis has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July, 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option.

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME SHEPARD MT. DAM
I.D. NUMBER 30324
SHEET NO. 1 OF 3
BY DTM DATE 6-5-79

SHEPARD MOUNTAIN DAM

DRAINAGE AREA

AREA = 7.07 SQ. MI (ST LOUIS DISTRICT C.O.E. AND U.S.G.S. 7.5-MIN. QUADS.)

UNIT HYDROGRAPH PARAMETERS

KIRPICH METHOD:

t_c = 0.83 HRS (FROM TIME OF CONCENTRATION NOMOGRAPH, KENTUCKY DEPT. OF HIGHWAYS)

L = 0.6 t_c
= 0.5 HRS

WHERE LENGTH = 20,000' AND SLOPE = 6%

CURVE NUMBER METHOD:

$$L_{AG}(L) = \frac{l^{0.8}(S+1)^{0.7}}{1900\, Y^{0.5}} = \frac{(20000)^{0.8}(2.49)^{0.7}}{1900\,(20)^{0.5}}$$

$$= \frac{(3759)(1.90)}{8497} = \underline{0.6 \text{ HRS.}}$$

WHERE l = GREATEST FLOW LENGTH IN FEET.
$S = \frac{1000}{CN} - 10$ AND CN = CURVE NUMBER
Y = SLOPE IN %

LOSS RATE AND BASE FLOW

STRTL = 1 INCH
CNSTL = 87 SCS CURVE NUMBER
STRTQ = 1.5 CFS/MI.^{2}
QRCSN = 0.05 (5% OF PEAK FLOW)
RTIOR = 2.5

UTILIZED ANTECEDENT MOISTURE CONDITION II

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

DAM NAME [illegible]
I.D. NUMBER [illegible]
SHEET NO. 3 OF 3
BY [illegible] DATE [illegible]

PROBABLE MAXIMUM STORM

FROM HZ NO. 33

PMP INDEX RAINFALL (ZONE 7) = 26.5 INCHES
R_6 = 102%, R_{12} = 120%, R_{24} = 130%

ELEVATION-AREA-CAPACITY RELATIONSHIP

SPILLWAY CREST ELEV. = 977', AREA = 0 ACRES
TOTAL STORAGE = 168 AC.FT
(FROM FIELD INSPECTION DATA, ST. 102 & 3 ST. C.O.E. INFO. AND USGS 7.5-MIN. QUAD.)

ELEV. 930' AREA = 33 ACRES
ELEV. 1000', AREA = 104 ACRES

From Conic Method for Reservoir Volume, Flood Hydrograph Package (HEC-1), Dam Safety Version (Users Manual).

$H = 3V/A = 3(168)/21 = 24'$

∴ ELEV. WHERE CAPACITY EQUALS ZERO:
977 - 24' = 953'

ELEVATION (FT)	953	977	990	955	991	1000
AREA (AC)	0	21	33	50	70	104

SPILLWAY DISCHARGE

DETERMINED BY (HEC-1)

SPILLWAY CREST ELEV = 977'
LENGTH OF SPILLWAY = 377.5
COEFFICIENT OF DISCHARGE = 3.2

L. ROBERT KIMBALL & ASSOCIATES
CONSULTING ENGINEERS & ARCHITECTS
EBENSBURG PENNSYLVANIA

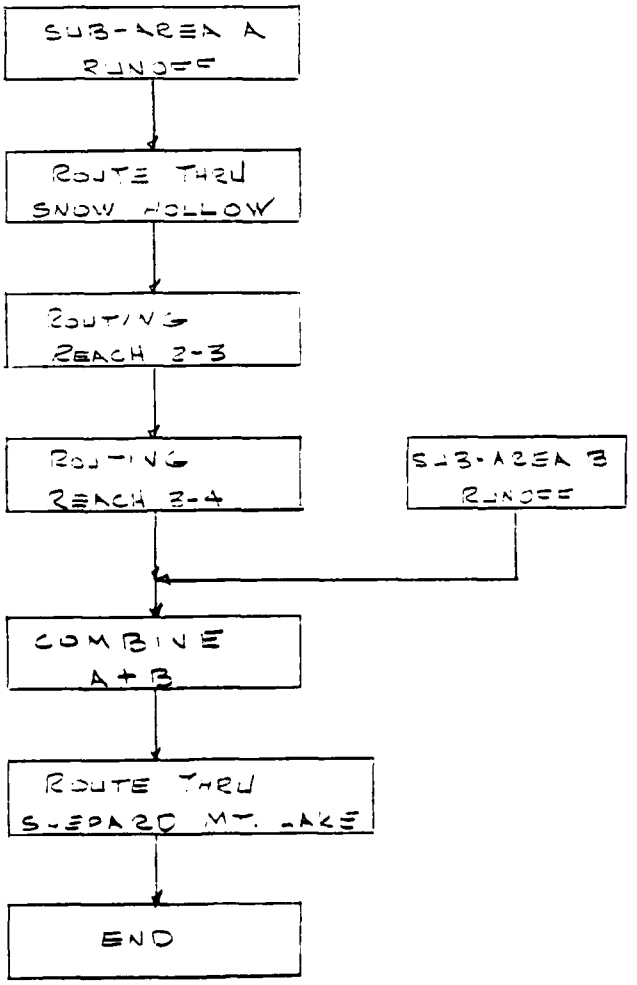
DAM NAME SHEPARD MT. DAM
I.D. NUMBER 30324
SHEET NO. 3 OF 3
BY CTM DATE 6-15-79

OVERTOPPING PARAMETERS

TOP OF DAM ELEV. = 979'
COEFFICIENT OF DISCHARGE = 3.0
LENGTH = 259' (ΔL_{MAX}=259', ΔV_{MAX} = 784')

UPSTREAM CONDITIONS (SCHEMATIC NETWORK)

SNOW HOLLOW LAKE APPROX. 14,000' UPSTREAM. EVALUATED EFFECTS ON SHEPARD MOUNTAIN LAKE DAM.



```
A1       ANALYSIS OF AN INTERMEDIATE RATIO RATIOS OF 1%
A2       HYDROLOGIC-HYDRAULIC ANALYSIS OF CAPACITY OF SHOPPORD MOUNTAIN LAKE
A3       RATIOS OF PEAK FLOWS THROUGH THE RESERVOIR (MISSOURI #205241
0    205                                                                  2
KK   3
I    1        6        1
J    .1       .2       .3       .4       .5       1                      1
K    0        1
BA       RUNOFF  (SUM-AREA A)
M    1        2        .75              7.27     1                      1
P                 250.     105      120      130
P                                                          -1       -.94
KK       .13
P    -1.5     -.05     7.5
K    1        3                                                    1
*1       ROUTE THROUGH SNOW HOLLOW LAKE
                                                 1        1
Y1   1                                                          -1.78    -1
YR   1278     1230     1281     1282     1285     1283.4   1284     1285     1286     1287
YS   0        71       195      460      1051     1405     2350     3078     7476     11539
QS   0        69       501      1067
AE   1278     1280     1290     1300
QI   1278
QO   1282.4
K    1        3                                                    1
A1       CHANNEL ROUTING - MOD PULS REACH 2-3
Y                                 1        1
Y1   1
X    .05      .05      .05      1055     1130     2000     .04
X7   0        1130     300      1080     900      1060     745      1059     755      1055
X8   1000     1060     1200     1080     1400     1100
K    1        4                                                    1
```

```
KI      CHANNEL ROUTING - MOD PULS REACH #4
Y                                       1
YI      1
YP    .06     .05     .06     .27    1420    7500    .81
YT      0     1020     150     1000    650     980    145     977     155     977
YY    1000    920     1350    1000    2500    1020
K       0       5                                       1
KI      RUNOFF  (SUB-AREA B)
M       1       2       6.32            2.07    1                       1
P               20.5    102     130     130
F                                                       -1      -87
W2              .5
X     -1.5      -.05    2.5
K       2       6                                       1
KI      COMBINE  RUNOFF  (SUB-AREAS A+B)
K       1       7                                       1
KI      ROUTE THROUGH RESERVOIR  (SHEPARD MT. LAKE)
Y                                       1       1
```

$1	Y1	1					
$2	$A	0	21	35	56	70	105
$3	$E	954	977	980	980	981	1000
$4	$I	977	977.5	3.2	1.5		
$5	$O	977	3.5	1.5	954		
$6	$U	0	35	50	203	231	252
$7	$V	977	977	980	981	982	994
$8	K	99					

****
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION JULY 1978
LAST MODIFICATION 26 FEB 79
****

RUN DATE 79/06/13.
TIME 15.46.24.

ANALYSIS OF DAM OVERTOPPING USING RATIOS OF PMF
HYDROLOGIC-HYDRAULIC ANALYSIS OF SAFETY OF SHEPARD MOUNTIAN LAKE
RATIOS OF PMF ROUTED THROUGH THE RESERVOIR (MISSOURI =30324)

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
288	0	5	0	0	0	0	0	0	0

JOPER	NWT	LROPT	TRACE
5	0	0	0

MULTI-PLAN ANALYSES TO BE PERFORMED
NPLAN= 1 NRTIO= 6 LRTIO= 1

RTIOS= .10 .20 .30 .40 .50 1.08

****

SUB-AREA RUNOFF COMPUTATION

RUNOFF (SUB-AREA A)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
1	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

PUNCH	IOPT	TABLA	SNAP	TRSDA	TRSPC	PAUSE	LSAME	ISAME	LOCAL
1	2	.75	0.00	7.62	1.00	0.000	1	1	0

RAIN DATA

SDATE	SMIN	RAIN	RAIN	RAIN	RAIN	RAIN	RAIN
0.00	26.50	1102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LOSPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	DLTKS	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-84.00	0.00	0.00

CURVE NO = -84.00 WETness = -1.00 EFFECT CN = 84.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .13

RECESSION DATA

STRTQ= -1.50 QRCSN= -.25 RTIOR= 2.00

TIME INCREMENT TOO LARGE--UNHG IS GT LAG/21

UNIT HYDROGRAPH TO END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .13 VOL= 1.00

949. 2118. 1537. 657. 301. 137. 62. 28. 14. 3.

0 MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q	END-OF-PERIOD FLOW MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	.05	1	.01	0.00	.01	1.	1.01	12.05	145	.23	.21	.01	499.
1.01	.10	2	.01	0.00	.01	1.	1.01	12.10	146	.23	.21	.01	816.
1.01	.15	3	.01	0.00	.01	1.	1.01	12.15	147	.23	.21	.01	1047.
1.01	.20	4	.01	0.00	.01	1.	1.01	12.20	148	.23	.21	.01	1148.
1.01	.25	5	.01	0.00	.01	1.	1.01	12.25	149	.23	.21	.01	1197.
1.01	.30	6	.01	0.00	.01	1.	1.01	12.30	150	.23	.21	.01	1221.
1.01	.35	7	.01	0.00	.01	1.	1.01	12.35	151	.23	.21	.01	1234.
1.01	.40	8	.01	0.00	.01	1.	1.01	12.40	152	.23	.22	.01	1241.
1.01	.45	9	.01	0.00	.01	0.	1.01	12.45	153	.23	.22	.01	1247.

HYDROGRAPH ROUTING

ROUTE THROUGH SNOW HOLLOW LAKE

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
2	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT
1	0	0	0.000	0.000	0.000	-1278.	-1.

STAGE	1278.00	1280.00	1281.00	1282.00	1283.00	1283.40	1284.00	1285.00	1286.00
1287.00									
FLOW	0.00	71.00	195.00	460.00	1081.00	1405.00	2350.00	3978.00	7416.00
11539.00									
CAPACITY=	0.	68.	501.	1067.					
ELEVATION=	1278.	1280.	1290.	1300.					

CREL	SPWID	COQW	EXPW	ELEVL	COQL	CAREA	EXPL
1278.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
1283.4	0.0	0.0	0.

STATION 2, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 ..... INITIAL VALUE ..... SPILLWAY CREST ..... TOP OF DAM

	ELEVATION			
	STORAGE			
	OUTFLOW			

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	FREEBOARD DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	1280.43	0.00	87.	425.	0.00	18.08	0.00
.20	1281.82	0.00	147.	913.	0.00	16.25	0.00
.30	1282.92	0.00	194.	1537.	0.00	16.00	0.00
.40	1284.72	.12	272.	1931.	.58	15.92	0.00
.50	1284.25	.65	252.	2761.	.83	15.92	0.00
1.00	1286.00	2.40	328.	7408.	3.92	15.83	0.00

PLAN 1 STATION 3

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	124.	1055.1	18.17
.20	403.	1055.5	16.83
.30	935.	1056.1	16.33
.40	1594.	1056.6	16.17
.50	2393.	1057.4	16.08
1.00	6420.	1058.4	15.92

PLAN 1 STATION 4

	MAXIMUM	MAXIMUM	TIME

[illegible]	[illegible]	[illegible]	[illegible]
.1[illegible]	[illegible]	[illegible]	19.[illegible]
[illegible]	[illegible]	[illegible]	17.7[illegible]
.4[illegible]	770.	[illegible]	[illegible]
[illegible]	1370.	[illegible]	[illegible]
[illegible]	1947.	[illegible]	[illegible]
[illegible]	5121.	[illegible]	[illegible]

WATERSHED STATE IS 930.0

SUB-AREA RUNOFF COMPUTATION

RUNOFF (SUB-AREA 2)

ISTAO	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
5	0	0	0	0	0	1	0	0

HYDROGRAPH DATA

IHOUR	IDUR	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
1	2	0.32	0.00	7.07	1.00	0.300	0	1	0

PRECIP DATA

SPFE	PMS	R6	R12	R24	R48	R72	R96
0.00	26.50	102.00	120.00	130.00	0.00	0.00	0.00

LOSS DATA

LROPT	STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0	0.00	0.00	1.00	0.00	0.00	1.00	-1.00	-87.00	0.00	0.00

CURVE NO = -87.00 RETNSS = -1.00 EFFECT CN = 87.00

UNIT HYDROGRAPH DATA

TC= 0.00 LAG= .50

RECESSION DATA

STRTQ= -1.50 QRCSN= -.05 RTIOR= 2.50

UNIT HYDROGRAPH 32 END OF PERIOD ORDINATES, TC= 0.00 HOURS, LAG= .50 VOL= 1.00

49129.	52632.	53219.	51274.	47694.	42822.	37899.	33809.	30428.	27730.
25518.	23735.	22349.	21254.	20363.	19604.	18914.	18232.	17564.	16900.
16234.	15568.	14918.	14946.	14660.	14409.	14134.	13705.	13057.	12083.
10851.	9504.	8160.	6926.	5843.	4964.	4299.	3771.	3394.	3155.
2981.	2822.	2527.	2345.	2176.	2052.	1968.	1896.	1835.	1782.
1739.	1695.	1659.	1627.	1599.	1574.	1553.	1535.	1518.	1503.
1489.	1475.	1463.	1451.	1440.	1429.	1419.	1409.	1400.	1392.
1383.	1376.	1368.	1361.	1355.	1348.	1342.	1336.	1331.	1326.
1320.	1316.	1311.	1307.	1303.	1299.	1295.	1292.	1289.	1286.
1284.	1281.	1279.	1277.	1275.	1273.	1271.	1270.		

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	53219.	19682.	6127.	6127.	1764573.
CMS	1507.	556.	173.	173.	49967.
INCHES		25.85	32.25	32.25	32.25
MM		656.76	819.05	819.05	819.05
AC-FT		9745.	12153.	12153.	12153.
THOUS CU M		12020.	14990.	14990.	14990.

********** ********** ********** ********** **********

HYDROGRAPH ROUTING

ROUTE THROUGH RESERVOIR (SHEPARD MT. LAKE)

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME	ISTAGE	IAUTO
7	1	0	0	0	0	1	0	0

ROUTING DATA

QLOSS	CLOSS	AVG	IPES	ISAME	IOPT	IPMP	LSTR
0.0	0.000	0.00	1	1	0	0	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA	ISPRAT

		1	0	0	0.000	0.000	0.000	-977.	0

SURFACE AREA=	0.	21.	35.	50.	70.	104.
CAPACITY=	0.	166.	248.	494.	814.	1591.
ELEVATION=	953.	977.	980.	985.	991.	1000.

CREL	SPRD	COXW	EXPW	FLEVL	COQE	CAREA	EXPE
977.0	977.5	5.7	1.5	0.0	0.0	0.0	0.0

DAM DATA

TOPEL	COQD	EXPD	DAMWID
979.0	3.0	1.5	259.

CREST LENGTH AT OR BELOW ELEVATION	0. 977.0	43. 979.0	89. 980.0	209. 981.0	239. 982.0	259. 984.0

STATION 7, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

OUTFLOW

0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
0.	0.	0.	0.	0.	0.	0.	0.	0.	0.
1.	1.	1.	1.	2.	2.	3.	4.	4.	5.
6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
16.	17.	18.	19.	20.	21.	22.	23.	24.	25.
26.	26.	27.	28.	29.	30.	30.	31.	32.	32.
33.	34.	34.	35.	37.	40.	46.	53.	63.	76.
90.	106.	121.	137.	151.	165.	177.	188.	199.	207.
215.	223.	229.	235.	240.	245.	249.	253.	257.	260.
263.	266.	269.	271.	273.	276.	278.	280.	282.	283.
285.	287.	288.	290.	291.	292.	294.	295.	296.	297.

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS					
				RATIO 1 .10	RATIO 2 .20	RATIO 3 .30	RATIO 4 .40	RATIO 5 .50	RATIO 6 1.00
HYDROGRAPH AT	1	.75	1	1052.	2104.	3155.	4207.	5259.	10518.
	(	1.94)	(	29.78)(	59.57)(	89.35)(	119.13)(	148.91)(	297.83)(
ROUTED TO	2	.75	1	125.	413.	1032.	1911.	2761.	7408.
	(	1.94)	(	3.53)(	11.70)(	29.23)(	54.12)(	78.19)(	209.77)(
ROUTED TO	3	.75	1	124.	403.	935.	1594.	2393.	6420.
	(	1.94)	(	3.50)(	11.42)(	26.49)(	45.13)(	67.75)(	181.80)(
ROUTED TO	4	.75	1	120.	380.	778.	1300.	1947.	5121.
	(	1.94)	(	3.40)(	10.75)(	22.04)(	36.80)(	55.14)(	145.02)(
HYDROGRAPH AT	5	6.32	1	4817.	9635.	14452.	19269.	24087.	48173.
	(	16.37)	(	136.41)(	272.82)(	409.24)(	545.65)(	682.06)(	1364.12)(
2 COMBINED	6	7.07	1	4872.	9820.	14907.	20106.	25624.	53219.
	(	18.31)	(	137.97)(	278.08)(	422.12)(	569.35)(	725.58)(	1506.98)(
ROUTED TO	7	7.07	1	4649.	9489.	14514.	19632.	25048.	52054.
	(	18.31)	(	131.64)(	268.70)(	410.99)(	555.91)(	709.29)(	1474.00)(

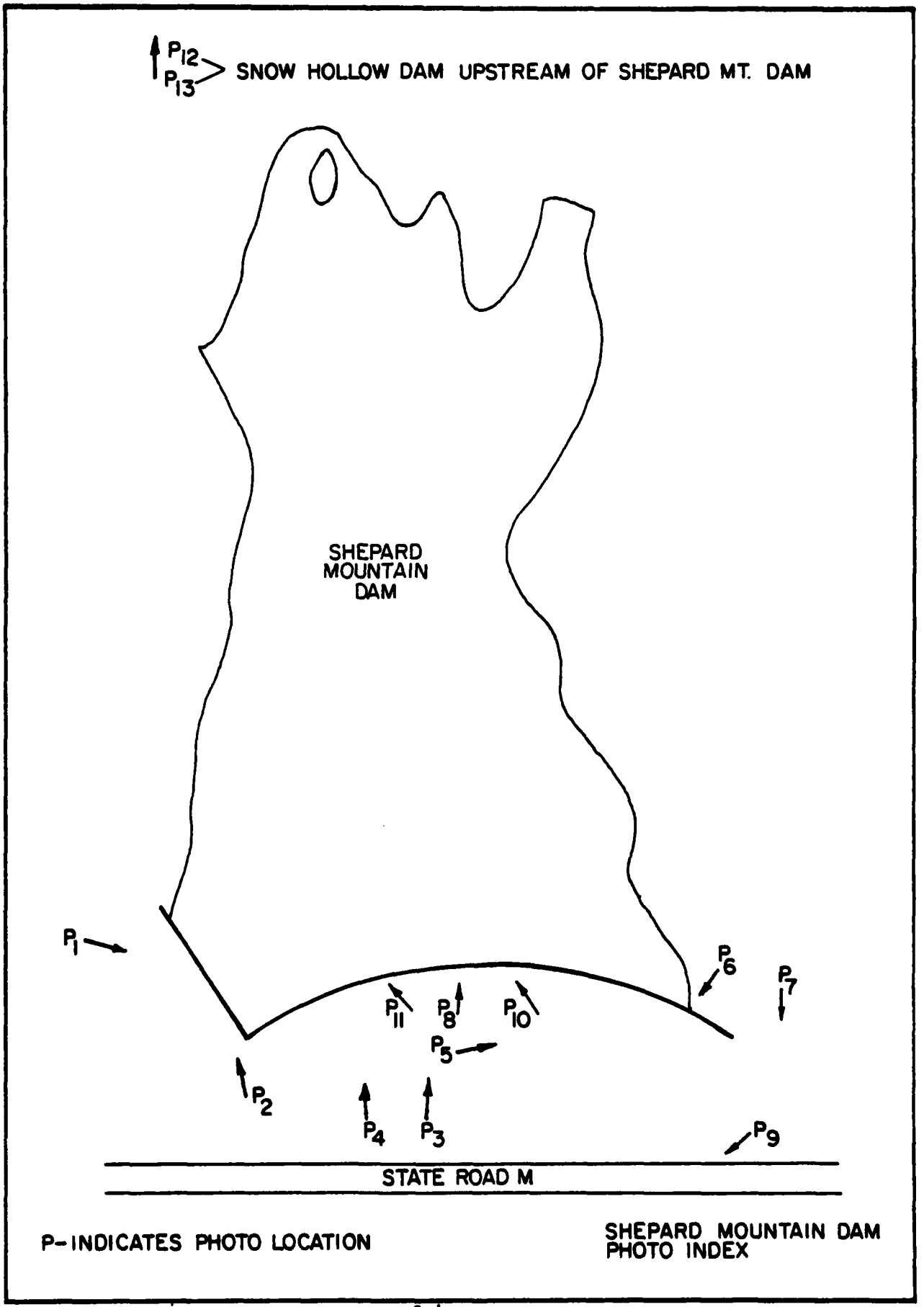
SUMMARY OF DAM SAFETY ANALYSIS

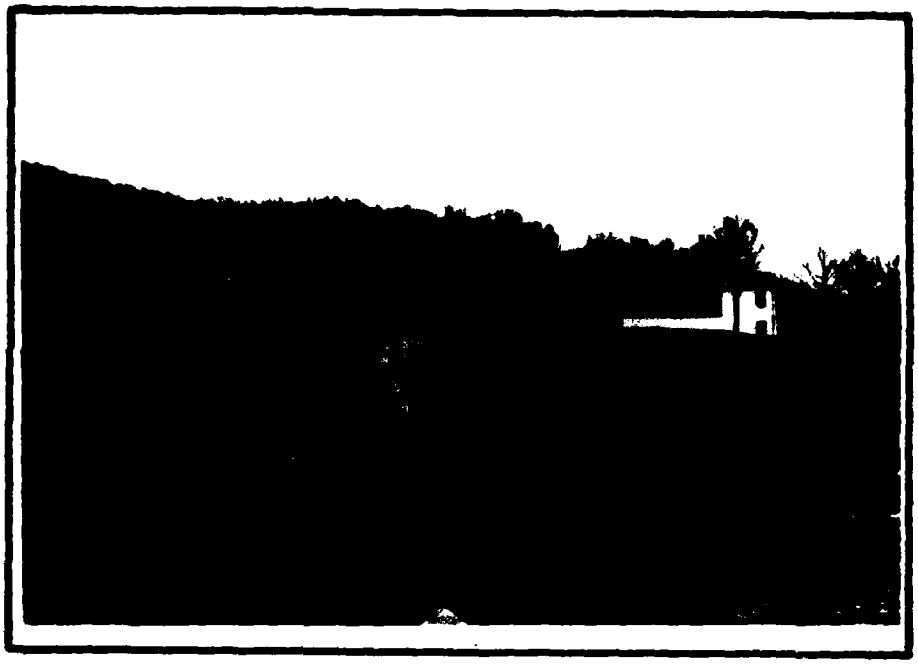
[illegible]	ELEVATION	[illegible]	[illegible]	TOP OF DAM
	INITIAL STORAGE	168.	0.	217.
	OUTFLOW	0.	0.	3556.

SAFETY CHECK FLOOD	MAXIMUM RESERVOIR W.S. ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	975.38	.38	229.	4049.	.67	16.17	0.00
.20	980.71	1.71	271.	9869.	1.92	16.17	0.00
.50	982.76	2.76	311.	14614.	4.75	16.17	0.00
.40	982.65	3.65	347.	19532.	5.75	16.17	0.00
.50	983.49	4.49	383.	25045.	6.08	16.17	0.00
1.00	986.95	7.95	558.	52756.	6.92	16.17	0.00

APPENDIX C

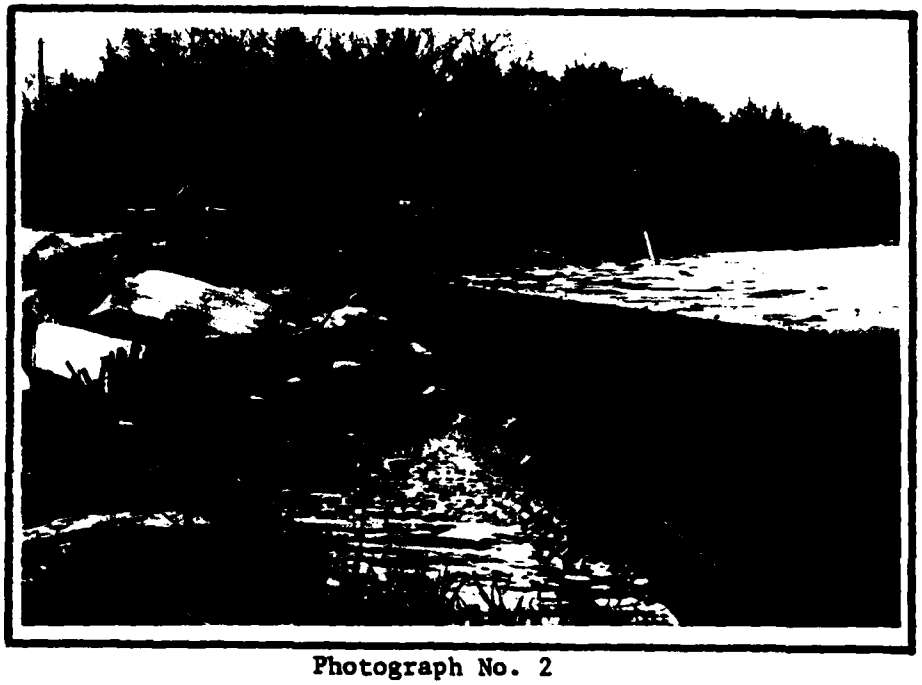
PHOTOGRAPHS


P12
P13
SNOW HOLLOW DAM UPSTREAM OF SHEPARD MT. DAM
SHEPARD MOUNTAIN DAM
P1
P2
P3
P4
P5
P6
P7
P8
P9
P10
P11
STATE ROAD M
P-INDICATES PHOTO LOCATION
SHEPARD MOUNTAIN DAM PHOTO INDEX



Photograph No. 1

Dam from right abutment.



Photograph No. 2

Right abutment gravity section.

Photograph No. 3

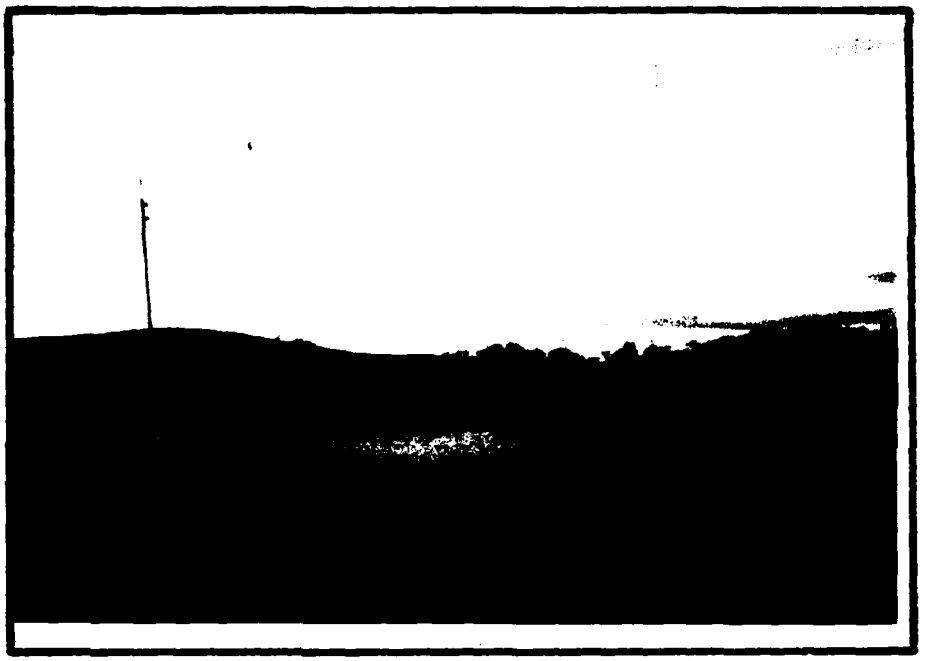
Downstream face of dam.

Photograph No. 4

Right abutment.

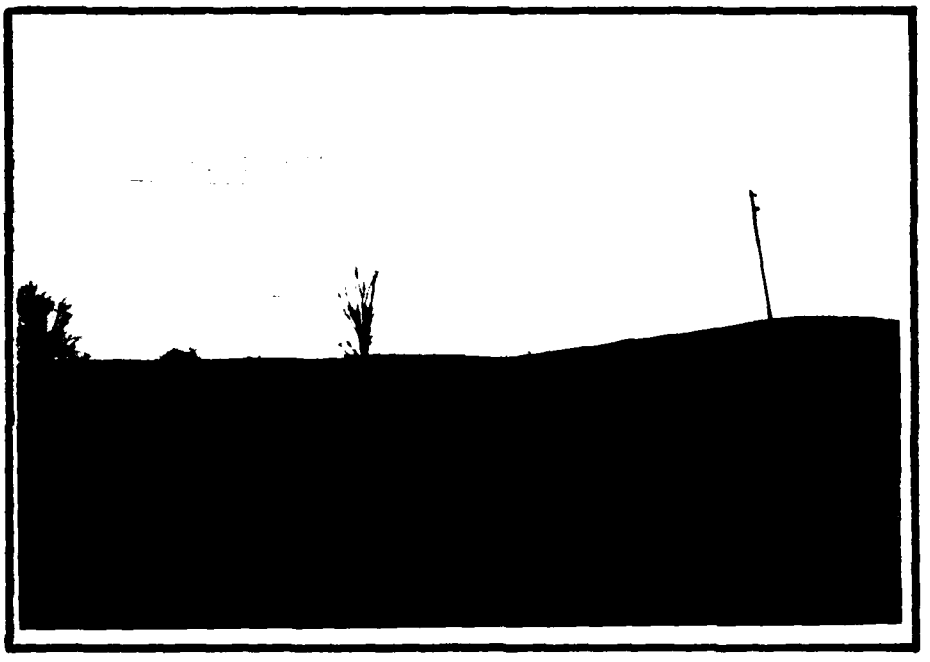
Photograph No. 5

Left abutment.



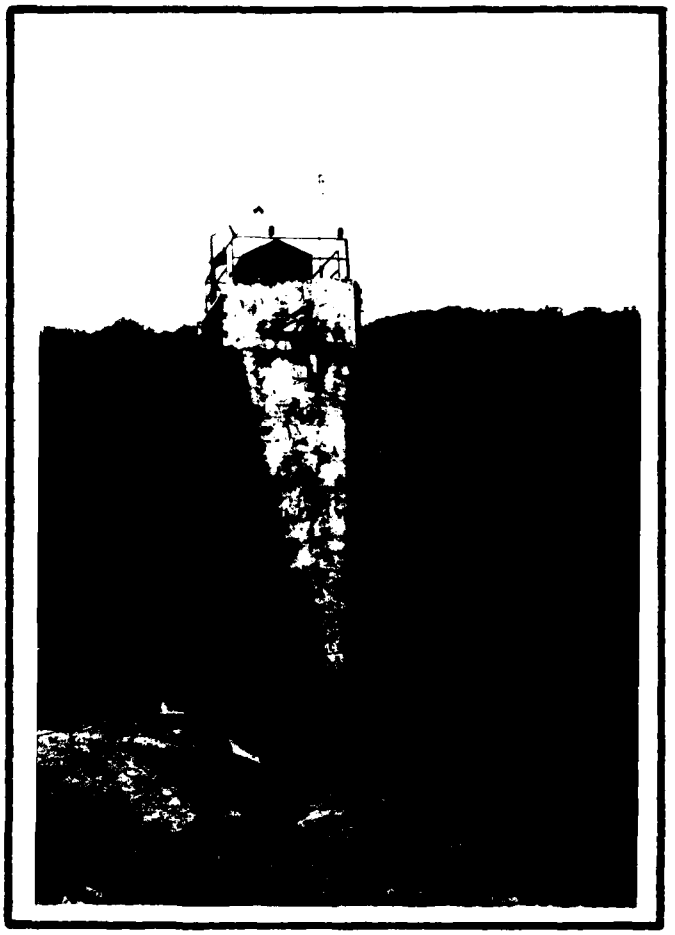
Photograph No. 6

Left abutment.



Photograph No. 7

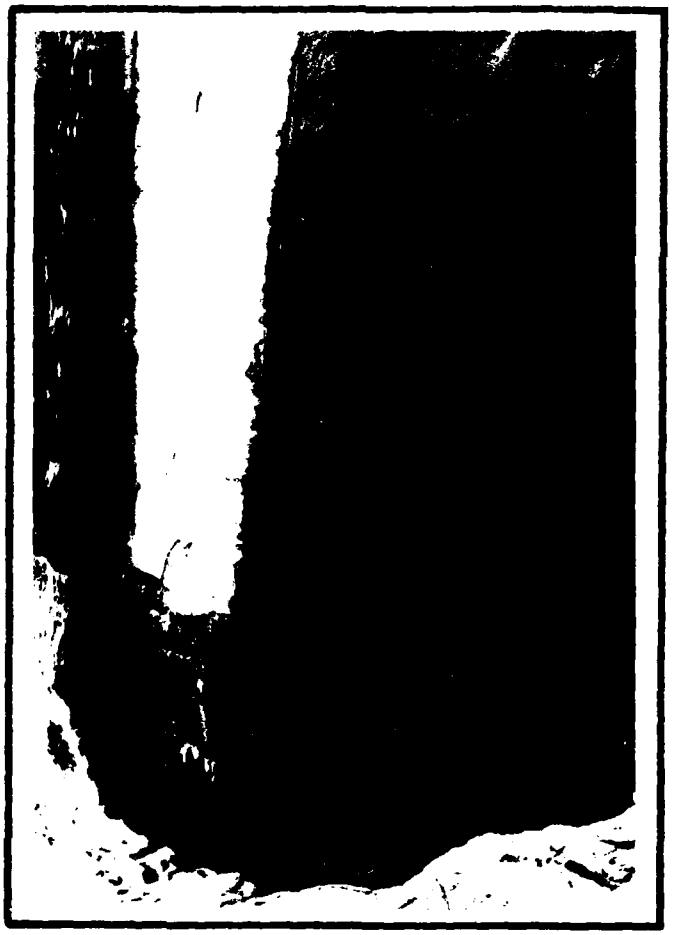
Left abutment wall.



Photograph No. 8

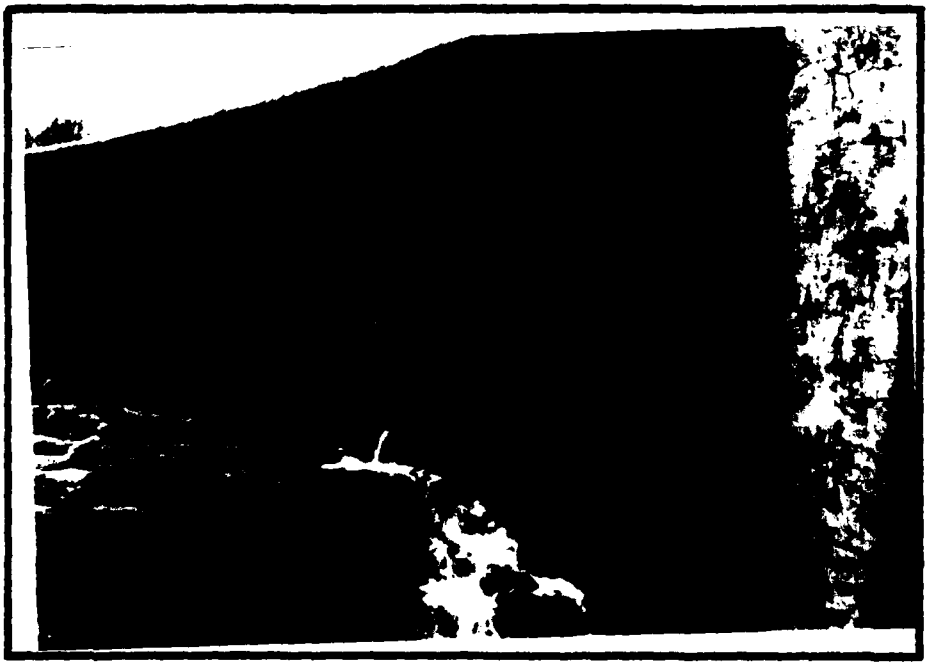
Outlet works.

Photograph No. 9
Roadway culvert below dam.

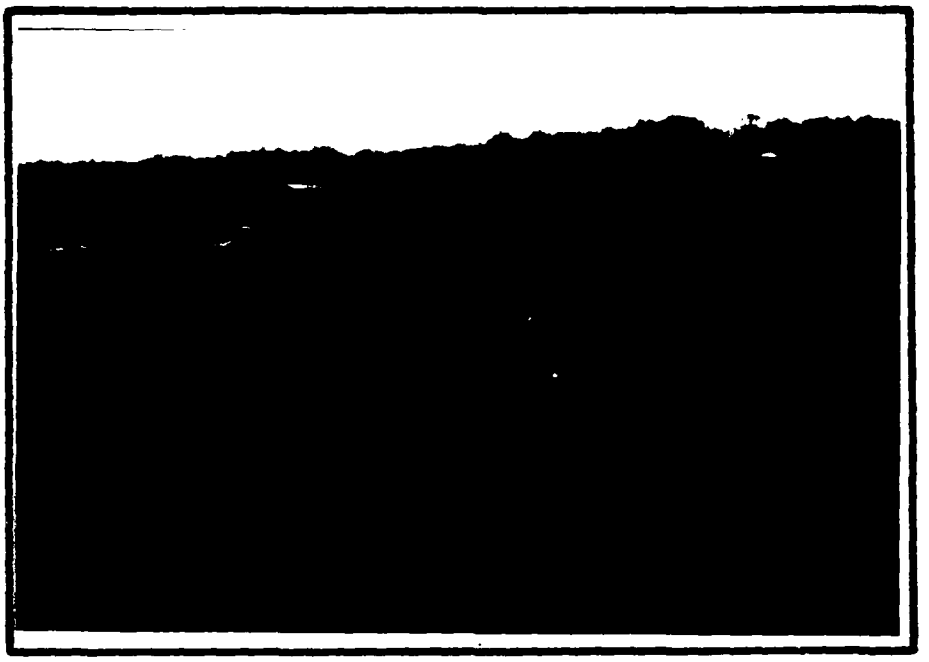


Photograph No. 10

Outlet works.



Photograph No. 11
Spalled Gunite.



Photograph No. 12

Snow Hollow Dam.

Photograph No. 13

Spillway of Snow Hollow Dam.


DATE
ILME